

ACTIVITY MODEL: SHIP REPAIR AND CONVERSION

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Preface

“Knowledge Based Modular Repair: Advanced Technology Applications for Ship Repair and Conversion” is one of the National Shipbuilding Research Program¹ (NSRP) projects. NSRP, a collaboration of the U.S. shipbuilding industry and government agencies, was established in 1998. The goals of the program are:

1. assist the U.S. shipbuilding industry in capturing a significantly increased share of the commercial market,
2. warship affordability for the Navy by reducing both acquisition and lifecycle cost, and
3. preserve the U.S. shipbuilding infrastructure by maintaining the capability to respond to the future demands of military and commercial consumers.

The Knowledge Based Modular Repair project is performed by the Atlantic Marine Holding Company (AMHC) and the National Institute of Standards and Technology (NIST). The goal of this project is to reduce cycle times, reduce costs, and improve the precision and overall quality of repair and conversion processes conducted by American ship repair yards. The project is being conducted in conjunction with repair and conversion operations at AMHC², in its two repair yards, as the sites to implement an array of best manufacturing practices that demonstrate how project goals can be accomplished.

The project is applying precision metrology techniques, manufacturing equipment and process characterization methodologies, and modeling and simulation technologies to AMHC repair and conversion operations that involve the fabrication of piping system and steel products. The intent of the project is to develop and implement at Atlantic Marine, Inc. (AMI), in Mobile a system that:

1. allows measurement data to be lifted from ships accurately and efficiently,
2. efficiently translates measurement data into production information, and
3. produces parts and assemblies with a high enough degree of confidence that they will fit on the ship without scrap or rework.

The project is also providing the ability for AMI Mobile to improve its planning and estimating processes by incorporating the capabilities of modeling and simulation into AMI systems.

¹ Maritech Advanced Shipbuilding Enterprise, “National Shipbuilding Research Program,” <http://www.nsrp.org>.

² The Atlantic Marine Holding Company has two repair yards: Atlantic Marine, Inc., in Mobile, Alabama, and Atlantic Dry Dock Corp., in Jacksonville, Florida.

In order to accomplish the project's objective, it is important to understand the practices that are commonly used by the industry. This document presents an activity model that identifies the functions involved in the ship repair and conversion industry, and the information flows required to perform those functions. The model presented in this report has been developed primarily based on information gathered during visits to both ship repairs and conversion facilities of AMHC, in Mobile, Alabama, and Jacksonville, Florida. Although the model describes all types of repairs/conversions, it puts special emphasis on those processes associated with steel systems, pipe systems, and paint. The document also includes two appendices: a node tree that describes functional hierarchy, and a glossary that provides definitions of all terms, including activity names and data/objects, used in the activity model.

The activity model presented in this document uses the IDEF0³ methodology. In the IDEF0 diagrams, activities/functions are represented by "boxes," data/objects, such as inputs, controls, outputs, and mechanisms (Icom), are represented by "arrows," tunneling is represented by a tunnel (a pair of parentheses, or sign "()") around the arrow's head or arrow's tail, and boxes and arrows are labeled. Tunneling an arrow implies that the arrow does not appear on a child or parent diagram. When a tunnel appears around the arrow's head, there is no corresponding Icom connected to the parent box. Similarly, when a tunnel appears on the arrow's tail, no corresponding Icom connected to the child box. IDEF0 does not model the timing of activities, nor does the ordering of the activities by label-number imply time of precedence.

ACKNOWLEDGEMENT

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DISCLAIMER

Certain commercial equipment, instruments, or materials are identified in this paper in order to facilitate understanding. Such identification does not imply recommendation or endorsement by the National Institute of Standards and Technology, nor does it imply that the materials or equipment identified are necessarily the best available for the purpose.

³ Federal Information Processing Standards Publication 183, "Integrated Definition for Functional Modeling (IDEF0)," National Institute of Standards and Technology, December, 1993.

Appendix 1: Node Tree/Functional Hierarchy

The IDEF0 activity model can be represented as a tree of activities, with all inputs, controls, outputs, and mechanisms omitted. Such a representation is called a node tree. The following presents the node tree of the activity model, “Execute Ship’s Repair/Conversion.”

[A0] Repair/conversion ship

[A1] Establish repair/conversion project

[A11] Analyze specification and/or perform shipcheck

[A12] Estimate material/equipment/labor requirements

[A13] Estimate project cost and time

[A14] Prepare and submit bid

[A15] Negotiate contract terms

[A2] Perform project team functions and prepare vessel arrive

[A21] Perform production turnover

[A211] Identify project management team

[A212] Download estimate from estimating

[A213] Distribute specification

[A22] Develop work summary

[A221] Identify yard item numbers and lead craft

[A222] Identify task items of un-priced extras, unsettled priced extras,
and settled extra

[A223] Generate and distribute work summary sheets

[A23] Generate and distribute work authorizations and production releases

[A231] Identify sub-tasks for each task

[A232] Identify requirements for each task

[A233] Identify owner furnished material for each task

[A234] Issue production releases to crafts

[A24] Develop and submit schedule

[A241] Develop master schedule

[A242] Revise schedule for growth/cancellation/delays

[A243] Update schedule to show progress

[A244] Archive schedule

[A245] Submit schedule to vessel owner, crafts, and project team

[A25] Perform vessel pre-arrival and arrival tasks

[A251] Hold pre-arrival meeting with vessel owner

[A252] Arrange vessel arrival and docking

[A253] Survey for ship inspection and measurements

[A254] Identify growth work items

[A26] Order material

[A3] Perform crafts activities

[A31] Initiate work orders

[A32] Assign production resources

[A33] Fabricate steel and pipes

[A331] Process steel measurements

[A3311] Lift measurements from vessel

[A3312] Convert measurements to CAD file

[A3313] Convert CAD file to equipment friendly language

[A332] Fabricate steel plates

[A3321] Mark and layout plates

[A3322] Cut plate parts

[A3323] Bend and roll plates

[A3324] Weld parts to plate

[A3325] Allow heat relief

[A3326] Test/inspect steel block/module

[A333] Sub-assemble steel blocks/module

[A334] Fabricate pipe modules

[A3341] Cut pipe

[A3342] Bend pipe

[A3343] Weld pipe

[A3344] Test/inspect pipe module

[A34] Perform repair work

[A341] Repair steel work

[A3411] Remove damaged steel work

[A3412] Transport steel module to/from vessel

[A3413] Fit-up steel module

[A3414] Weld steel module

[A3415] Test/inspect steel work

[A342] Repair pipe work

[A3421] Remove damaged pipe work

[A3422] Transport pipe module to/from vessel

[A3423] Fit-up pipe module

- [A3424] Weld pipe module
- [A3425] Test/inspect pipe work
- [A343] Perform painting work
 - [A3431] Receive paint job
 - [A34311] Receive job specification, work authorizations and production releases
 - [A34312] Develop notebook and duplicate a working copy
 - [A34313] Determine coating system
 - [A34314] Locate product data sheets and material safety data sheets
 - [A34315] Perform hull survey
 - [A34316] Adjust specification to accommodate changes based on survey
 - [A3432] Setup/examine/improve surface preparation
 - [A3433] Arrange and setup equipment and hoses
 - [A3434] Perform coating/touch-ups
 - [A34341] Do painting
 - [A34342] Allow paint to be dried
 - [A34343] Inspect subsequent coat
 - [A3435] Inspect final coat
 - [A3436] Remove equipment from dock and clean dry dock
- [A344] Perform other work items such as machinery, electrical works
- [A35] Dispose waste and clean areas
- [A4] Sign off and prepare vessel depart

[A41] Develop test and inspection procedures

[A42] Perform inspection

[A43] Sign off contract

[A44] Issue invoice and collect payments

[A45] Depart vessel

Appendix 2: Glossary

The following terms are used in the activity model, “Execute Ship’s Repair/Conversion.” Terms included in this glossary are the activity names and data/objects that may be inputs, controls, outputs, or mechanisms (Icom). (An *input* is a data/object that is transferred by an activity. A *control* is a data/object that determines how or when an activity occurs, but is not transformed by it. An *output* is a data/object that is produced by or results from an activity. A *mechanism* is a person, facility, machine, or other agency that performs the activity.)

Adjust specification to accommodate changes based on survey (Activity A34316)

The act of modifying the specification to accommodate the changes based on the result of a survey.

Allow heat relief (Activity A3325)

The act of applying heat to promote stress relief and to reduce buckles on a steel plate due to the welding process.

Allow paint to be dried (Activity A34342)

Sufficient time to be allowed for paint to be dried before application of subsequent coat or if submersion of vessel.

Analysis result (Icom)

Result of analyzing the customer's specification. The analysis of the specification is performed to determine if the customer's requirements are feasible and to determine the cost to satisfy all requirements.

Analyze specification and/or perform shipcheck (Activity A11)

The analysis of the customer's specification is performed to determine if the customer's specification for the repair/conversion is feasible, and if it is feasible, then at what cost to the customer. Ship check is an actual survey performed by the project team to determine the repair requirements.

Archive schedule (Activity A244)

The act of recording all of the information about schedule including original and updated schedules.

Arrange and setup equipment and hoses (Activity A3433)

The act of setting up equipment on dock for painting purposes.

Arrange vessel arrival and docking (Activity A252)

The act of preparing equipment (e.g. bilge blocks and crane) and scheduling manpower prior to ship arrival for dry docking.

Assign production resources (Activity A32)

The act of assigning material and qualified individuals to a particular location, equipment, or work item.

Assigned labor and equipment (Icom)

Individuals to be assigned to particular locations, equipment, or work items.

Bend and roll plates (Activity A3323)

The act of bending and rolling steel plates to a desired geometric shape.

Bend pipe (Activity A3342)

The act of making a bend of pipe.

Bid (Icom)

An offer that describes price quotations and corporation's capabilities.

CAD drawings (Icom)

The ship design drawing that is generated by the CAD systems.

Communications from customer (Icom)

Communication from the customer regarding the repair/conversion project.

Condition reports (Icom)

Reports prepared by the crafts and submitted to the project team describing issues and problems.

Contract terms (Icom)

Mutually agreed, between the corporation and the customer, terms and conditions dealing with crafting, resources, inspection, payments, cost, and time of the project.

Convert CAD file to equipment friendly language (Activity A3313)

The act of converting steel measurements in the CAD file to an equipment friendly language file, such as NC machine codes, on disc.

Convert measurements to CAD file (Activity A3312)

The act of converting steel measurements to a CAD file for generating a CAD drawing.

Corporate Guidelines (Icom)

Guidelines provided by the corporation for operating procedures, performance, safety, testing and inspection, etc.

Customer general requirements (Icom)

Requirements of the customer related to craft repair practice, safety, quality, cost extra, etc.

Cut pipe (Activity A3341)

The act of cutting pipe into a desired dimensional length and geometric shape.

Cut plate parts (Activity A3322)

The act of cutting steel plate into desired geometric parts.

Depart vessel (Activity A45)

The supporting activity for preparing the vessel's departure from the shipyard.

Determine coating system (Activity A34313)

The act of determining the desired coating system for a particular paint job.

Develop and submit schedule (Activity A24)

The act of development and distribution of the schedule to all crafts, the project team and the owner. The development consists of developing the original schedule, revising the schedule (for growth, cancellations, weather delays and other impacts), and updating the schedule (for progress status.)

Develop master schedule (Activity A241)

The act of developing the original schedule. The schedule is to identify work calendars, manpower, start time, and end time for accomplishing the job.

Develop notebook and duplicate a working copy (Activity A34312)

The act of generating a notebook to include all paint work items.

Develop test and inspection procedures (Activity A41)

The act of developing necessary operations to perform a vessel's test and inspection for ensuring that the vessel is fully operational and the customer's requirements are met.

Dispose waste and clean areas (Activity A35)

The act of cleaning and removing waste from working areas.

Develop work summary (Activity A22)

The act of identifying yard item numbers, lead crafts, and generating work summary sheets.

Distribute specification (Activity A213)

The act of distributing the specification to the project team.

Do painting (Activity A34341)

The act of performing the painting job.

Download estimate from estimating (Activity A211)

The act of retrieving the project estimate from the estimating department.

Drawings/NC machine code (Icom)

Manual drawings, CAD drawings, or NC machine code of the repair parts.

Equipment (Icom)

Equipment used for performing the task. The equipment may be available at the facility, or it can be rented.

Equipment requirement (Icom)

Equipment required for performing the job.

Establish repair/ conversion project (Activity A1)

The act of pursuing a new repair/conversion project consists of five stages: 1). receive and analyze the customer's specification, 2). estimate the requirements of material, equipment, and labor for completing the job, 3). estimate the total time and cost requirements, 4). develop and submit the proposal, and 5). negotiate contract terms with the customer.

Estimate material/ equipment/ labor requirements (Activity A12)

The act of estimating material, manufacturing resources, skilled labor, and equipment required to accomplish the project. Levels of detail in this estimation are based on the information provided in the customer's specification.

Estimate project cost and time (Activity A13)

The act of estimating the total time and total cost required to perform the project. This estimation is based on the amount of material needed, the manufacturing resources and skilled labor used, and the requirements of the customer.

Fabricate pipe modules (Activity A334)

The act of fabricating the pipe modules at the shop.

Fabricate steel and pipes (Activity A33)

The act of fabricating steel plate and pipes modules at the shop.

Fabricate steel plates(Activity A332)

The act of fabricating steel plates at the shop.

Fit-up pipe module (Activity A3423)

The act of fitting-up a pipe module.

Fit-up steel module (Activity A3413)

The act of fitting-up a steel plate module.

Generate and distribute work summary sheets (Activity A223)

The act of generating and distributing the work summary sheets. These sheets are generated based on the estimating function project. The sheets list the work items that are specified in the owner specification and the work items that are growth extras.

Generate and distribute work authorizations and production releases (Activity A23)

The act of generating and distributing work authorizations and production releases to crafts.

Growth extras and estimates (Icom)

Growth work items with estimates. The growth work items, which are not presented in the original customer's specification, may be encountered while performing repair work or performing pre-arrival surveys.

Hold pre-arrival meeting with vessel owner (Activity A251)

The act of holding a vessel pre-arrival meeting to discuss the schedule and other issues and concerns relating to the project.

Identify growth work items (Activity A254)

The act of identifying growth work items.

Identify owner furnished material for each task (Activity A233)

The act of identifying material furnished by the customer.

Identify project management team (Activity A212)

The act of identifying the project management team that may include a project manager, coordinators, sub-contracting coordinator, and scheduler/planner.

Identify requirements for each task item (Activity A232)

The act of identifying a set of task requirements from the crafts based on the owner specification and estimate. The requirements include material, manufacturing resources, skilled labor, and equipment.

Identify sub-tasks for each task (Activity A231)

The act of identifying the operations' (sub-tasks') sequence for each task item.

Identify task items of un-priced extras, unsettled priced extras, and settled extras (Activity A222)

The act of identifying growth work items that have not been settled with the customer.

Identify yard item numbers and lead craft extras (Activity A221)

The act of assigning and matching yard item numbers to the original owner item numbers for the accounting system to track the job.

Initiate work orders (Activity A31)

The act of issuing a production notification to the customer and production orders to crafts.

Inspect final coat (Activity A3435)

The act of performing the final inspection of coatings.

Inspect subsequent coat (Activity A34343)

The act of performing an inspection after each paint coating. For a hull's paint work, the attending superintendent or customer's appointed representatives may be required to examine each coat applied prior to application of subsequent coat.

Inspection reports (Icom)

Reports describing the inspection results.

Invoices/payments (Icom)

Invoices of itemized charges for the customer and payments received from the customer.

Issue production releases to crafts (Activity A234)

The act of distribution of the production release to the craft level.

Issue invoice and collect payments (Activity A44)

The act of issuing the invoice to the customer and collecting payments from the customer.

Job performance status (Icom)

The status of the job progress.

Labor requirement (Icom)

The crafts required for performing the job. The crafts may include painters, steelworkers, pipe-fitters, welders, machinists, electricians, riggers, carpenters, etc. Subcontractors may be required on specialty instances.

Laws/rules/standards/regulations (Icom)

Laws, rules, and standards that govern various aspects of the enterprise's operations.

Lift measurements from vessel (Activity A3311)

The act of processing a steel measurement. Actual measurements are lifted, usually with a tape measure, after the vessel arrives.

List of sub-tasks of the task item (Icom)

A set of operations required to accomplish the task requirements.

Locate product data sheets and material safety data sheets (Activity A34314)

The act of adding Product Data Sheets and Material Safety Data Sheets in the paint job notebook.

Management team (Icom)

A team to manage the project or portions of the project. The team may consist of a project manager, project coordinators, a sub-contracting coordinator, and a scheduler/planner.

Manual drawings (Icom)

The ship design drawing that is generated manually.

Mark and layout plates (Activity A3321)

The act of marking and laying-out steel plates.

Material requirement (Icom)

Material required for performing the job.

Minutes (Icom)

A report resulting from the ship's pre-arrival meeting.

Negotiate contract terms (Activity A15)

The act of agreeing to the terms and conditions of the contract as negotiated by the shipyard and the customer.

NC machine code (Icom)

NC machine code in an equipment friendly language.

Notebook (Icom)

Notebook that records all paint work items.

Order material (Activity A26)

The act of procuring the required material for production in accordance with the process plan and the schedule.

Owner furnished material (Icom)

Material furnished by the customer for the project.

Owner furnished material for the task (Icom)

Material furnished by the customer for a particular task.

Owner work items (Icom)

Work items specified in the owner specification.

Owner specification (Icom)

Documentation specifying the customer's service requirements.

Perform coating/ touch-ups (Activity A3434)

The act of performing painting.

Perform crafts activities (Activity A3)

The act of performing repair/conversion, the stage after the planning and scheduling.

Perform hull survey (Activity A34315)

The act of conducting a hull survey with the ship's owner and a paint manufacture representative after the ship arrives and docks.

Perform inspection (Activity A42)

The act of performing the vessel inspection using the test and inspection procedures.

Perform other work items such as machinery, electrical works (Activity A344)

The act of performing production work items that are not steel jobs, pipe jobs, or paint jobs.

Perform painting work (Activity A343)

The act of performing the painting of work items.

Perform production turnover (Activity A21)

The act of presenting all project information from the estimating department to an assigned project manager when the bid is accepted.

Perform project team functions and prepare vessel arrive (Activity A2)

The act of assembling a project team, performing a production turnover, and identifying task items etc.

Perform repair work (Activity A34)

The act of performing all repair tasks identified in the project.

Perform vessel pre-arrival and arrival tasks (Activity A25)

The act of preparing for vessel arrival. The survey includes the first examination when the vessel arrives and the dock is pumped dry, as well as subsequent surveys as per repair specification.

Personnel (Icom)

A facility's personnel.

Pipe modules (Icom)

Pipe modules prepared for pipe repair.

Pipe parts (Icom)

Pipe parts prepared for making steel plates.

Plate stock (Icom)

Plate stock prepared for making steel blocks/modules.

Plates (Icom)

Plates that are prepared for plate repair.

Preliminary estimated cost (Icom)

Cost estimated to perform the project. It is estimated by analyzing the customer's specification, and it is used to prepare a bid.

Preliminary estimated time (Icom)

The time required for performing the project. It is estimated by analyzing the customer's specification, and it is used to prepare a bid.

Prepare and submit bid (Activity A14)

The formulation of a specific plan for the development and submittal of a proposal for the repair/conversion project. The development of the plan is based primarily on the customer's specification and the nature of the type of repair/conversion.

Process plan/work authorizations (Icom)

Documentation describing the sequence of operations that make up each task of the project, the necessary labor, material, and equipment to accomplish each task, and material furnished by the customer for each task.

Process steel measurements (Activity A331)

The act of processing steel measurements after the vessel arrives.

Production notification to owner (Icom)

A message, such as a schedule, issued to the customer about the start of repair/conversion process.

Production Release (Icom)

Work orders issued to crafts about the production job.

Purchased material (Icom)

Material purchased for the project.

Receive job specification, work authorizations and production releases (Activity A34311)

The act of receiving a job order from the project team. Information received includes the job specification, work authorizations and production releases.

Receive paint job (Activity A3431)

The act of receiving a painting job.

Remove damaged pipe work (Activity A3421)

The act of removing damaged pipes.

Remove damaged steel work (Activity A3411)

The act of removing damaged steel plates/modules.

Remove equipment from dock and clean dry dock (Activity A3436)

The act of removing equipment from the dock and cleaning the dry dock after painting work is complete.

Repair pipe work (Activity A342)

The act of performing pipe repair.

Repair steel work (Activity A341)

The act of performing steel plate repair.

Repair/ conversion ship (Activity A0)

The act of operating a ship repair/conversion project.

Requirements of labor/ material/equipment (Icom)

Labor, material, and equipment required for performing each task.

Revise schedule for growth/ cancellation/ delays (Activity A242)

The act of updating the schedule to include growth work items, cancellation work, or work delay due to weather or other impacts.

Schedule (Icom)

The plan describing work calendars, manpower, start time, end time, and shifts for each task.

Setup/examine/improve surface preparation (Activity A3432)

This activity is about surface preparation. It includes the preparation of the surface, examination of the surface preparation by the customer, and improvement of the grade of surface preparation. The surface preparation is required to meet the customer's requirement.

Sign off and prepare vessel depart (Activity A4)

The act of finalizing the project. This stage comes after all repairs have been completed, and the activities include perform inspection, sign off, and depart vessel.

Sign off contract (Activity A43)

The act of performing the project's sign-off.

Signed-off contract (Icom)

The contract that is signed off by the customer. Once all contract terms and conditions are met, the contract is ready for signing off.

Steel blocks/modules (Icom)

Steel blocks/modules ready for the steel repair.

Sub-assemble steel blocks/modules (Activity A333)

The act of sub-assembling the steel blocks/modules.

Submit schedule to vessel owner, crafts, and project team (Activity A245)

The act of distributing the project schedule from the planner/scheduler to all crafts, the project team, and the owner.

Survey for ship inspection and measurements (Activity A253)

The act of conducting ship surveys after the ship arrives and docks. The survey includes the first examination when the vessel arrives and docks, as well as subsequent surveys, as per repair specification, for gathering actual measurements.

Survey report (Icom)

The report resulting from the vessel's survey.

Systems (Icom)

Systems that are available at the facility.

Test and inspection procedures (Icom)

The plan for performing tests and inspection.

Test/inspect pipe module (Activity A3344)

The act of performing testing or inspection of the pipe module.

Test/inspect pipe work (Activity A3425)

The act of performing testing or inspection of the pipe repair work.

Test/inspect steel block/module (Activity A3326)

The act of performing testing or inspection of the steel block/module.

Test/inspect steel work (Activity A3415)

The act of performing testing or inspection of the steel repair work.

Transport pipe module to/from vessel (Activity A3422)

The act of transporting the pipe module to or from the vessel.

Transport steel module to/from vessel (Activity A3412)

The act of transporting the steel module to or from the vessel.

Update schedule to show progress (Activity A243)

The act of updating the schedule to show the project progress.

Vessel (Icom)

The ship for repair/conversion.

Waste (Icom)

All debris resulting from the project.

Weld parts to plate (Activity A3324)

The act of welding steel parts.

Weld pipe (Activity A3343)

The act of welding pipe sections.

Weld pipe module (Activity A3424)

The act of welding a pipe module.

Weld steel module (Activity A3414)

The act of welding a steel module.

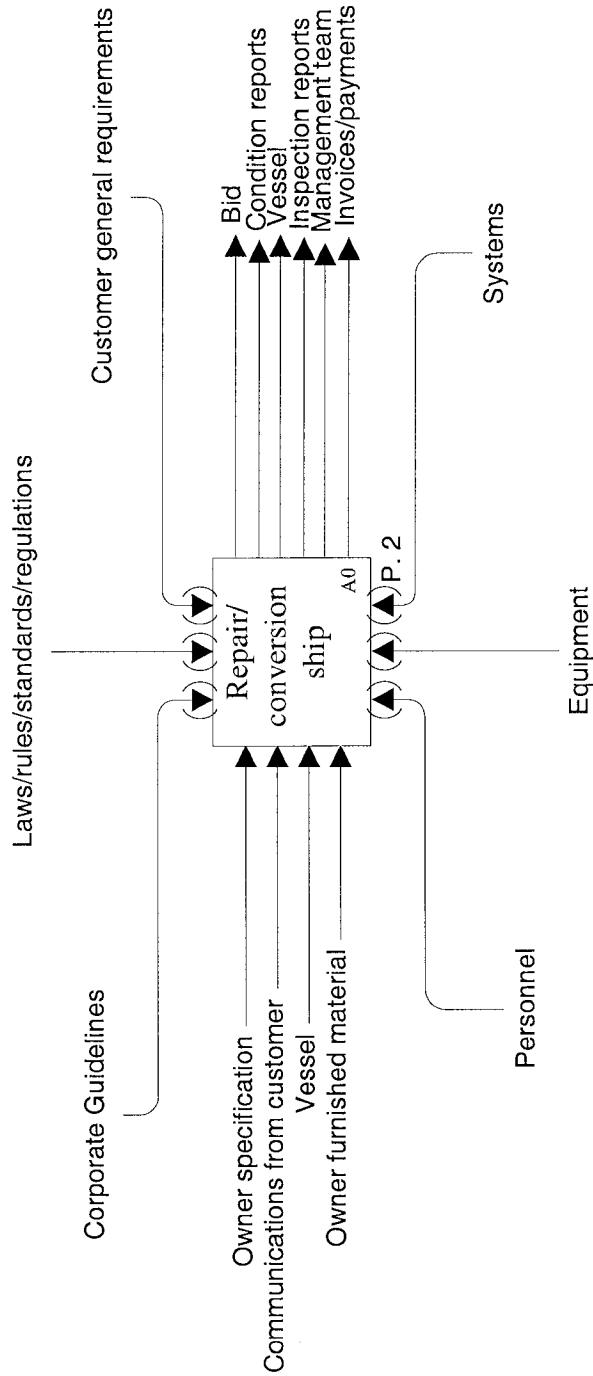
Work summary (Icom)

Work summary that is a set of sheets for specifying a work item number and a brief description for each task item in the project.

Yard items (Icom)

Yard item numbers that are assigned for the accounting system for tracking the job.

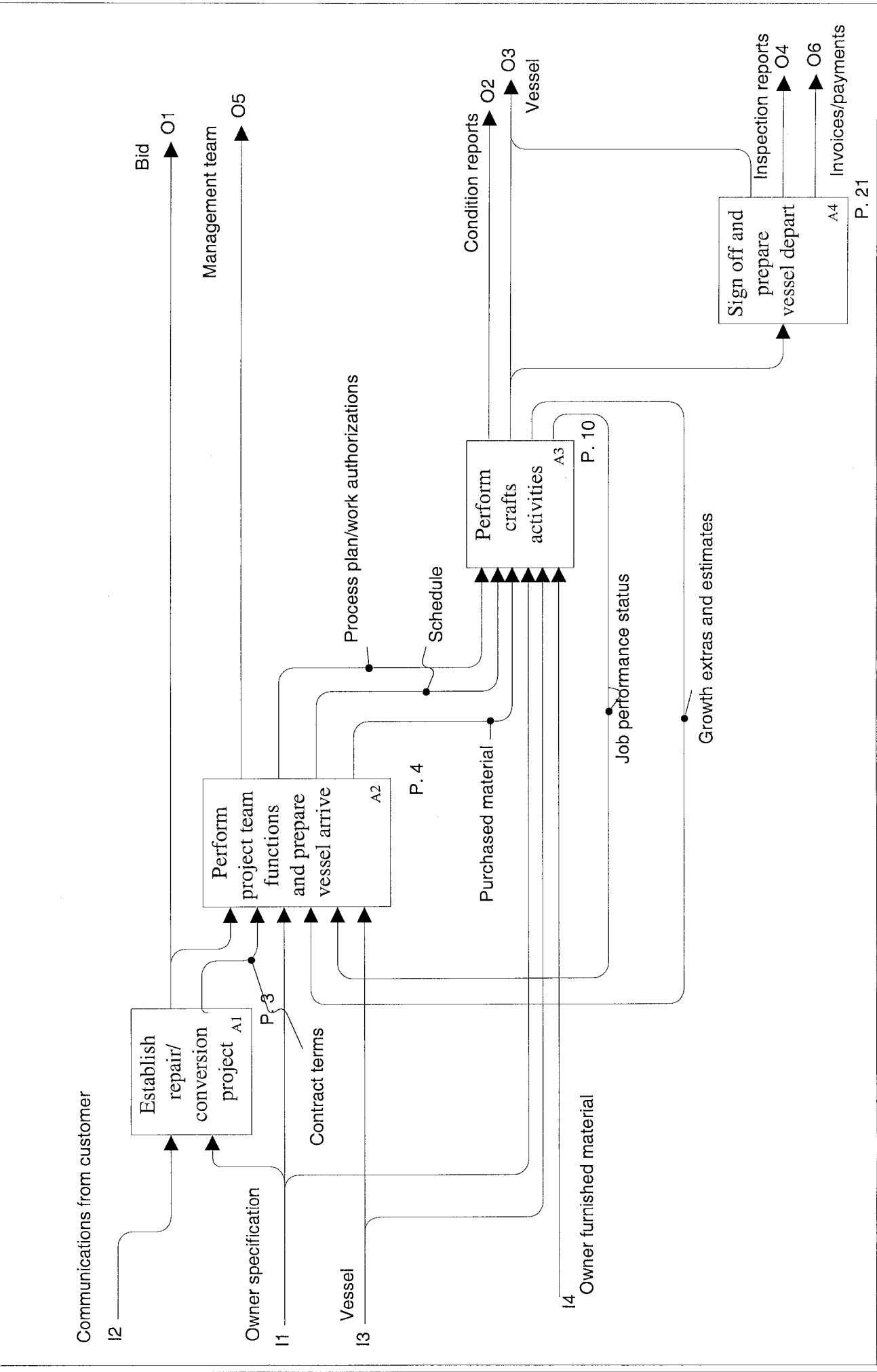
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Purpose: To provide an activity-oriented description of the functions and practices performed in the ship repair and conversion industry.

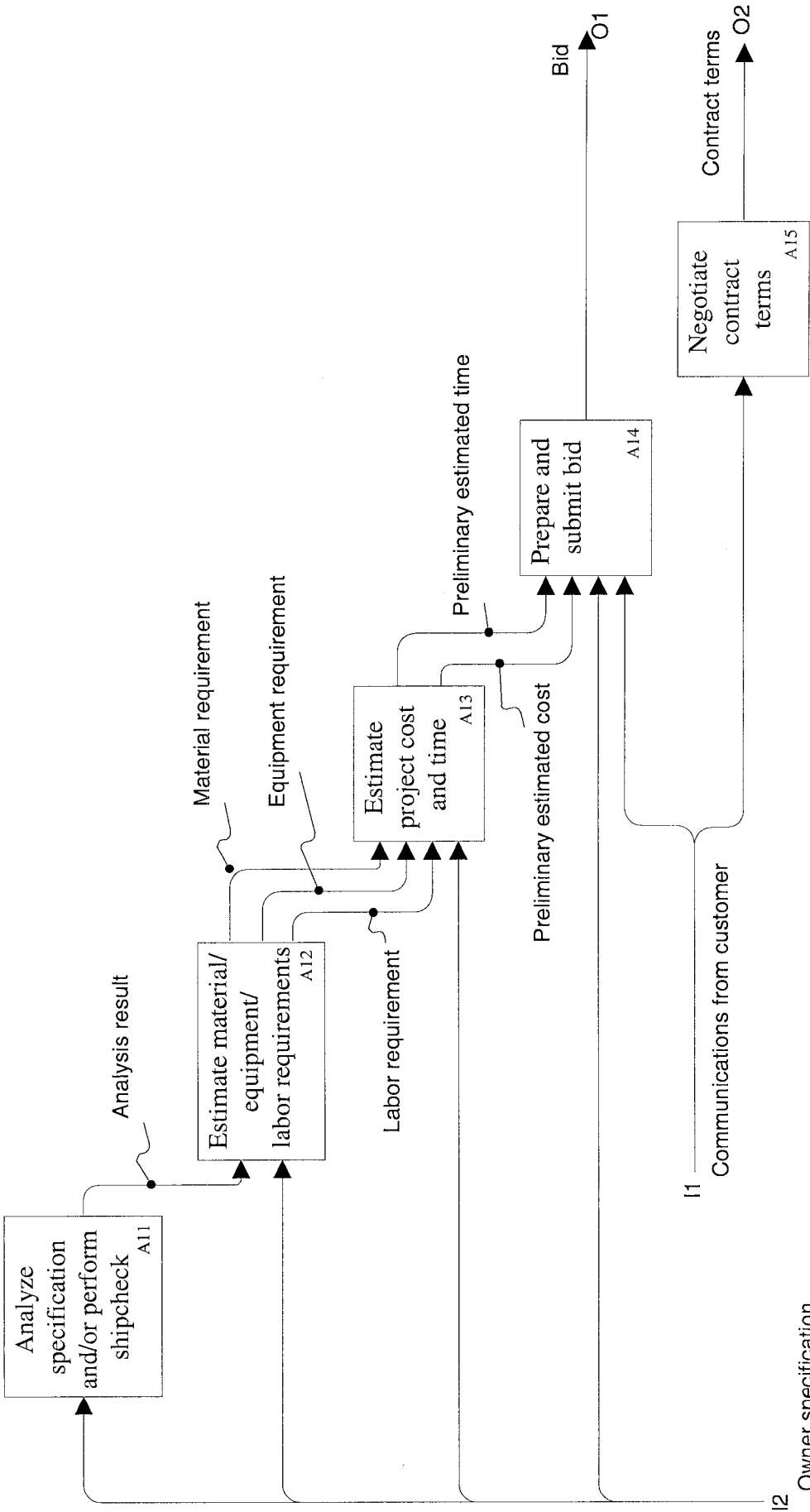
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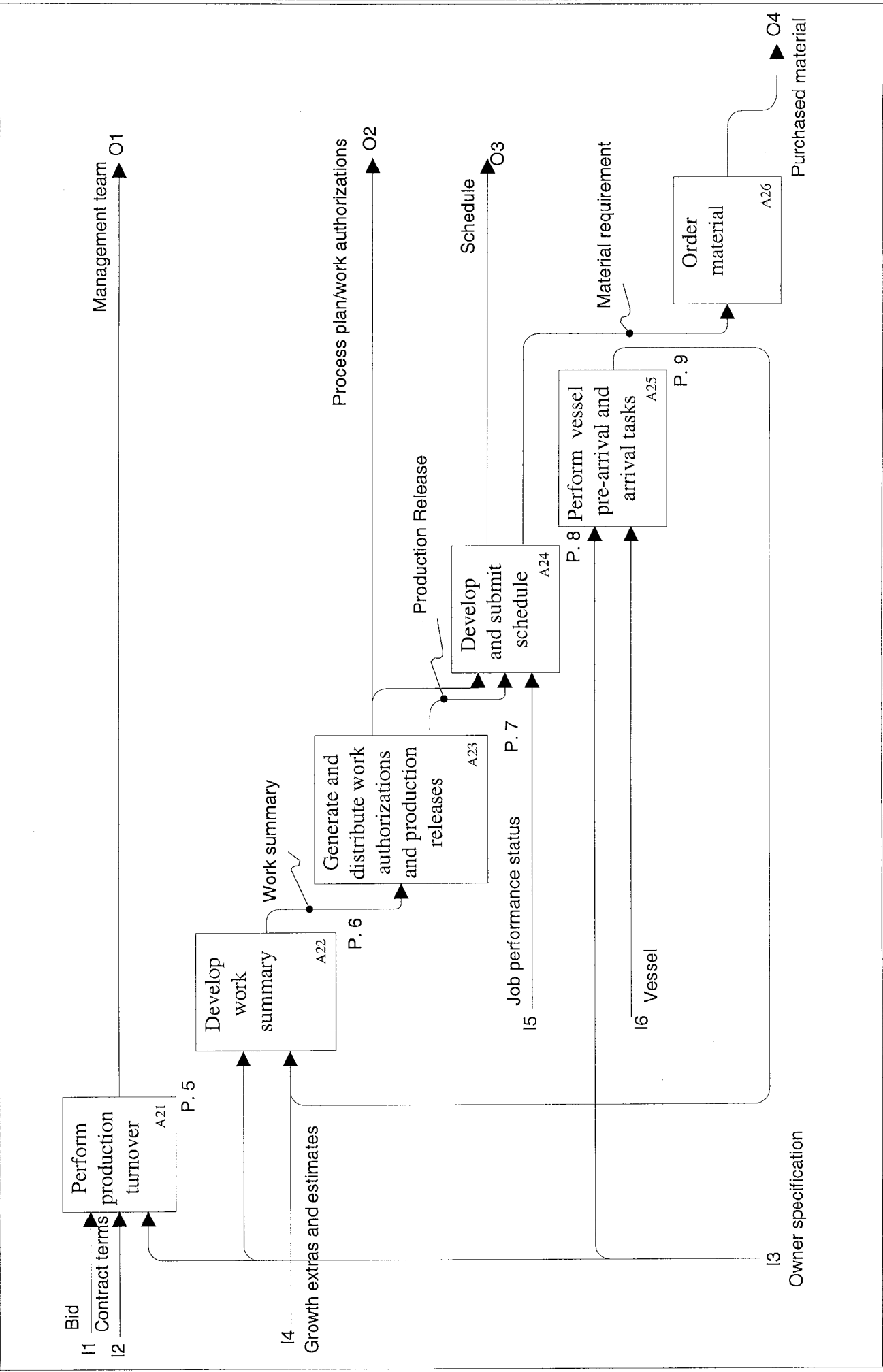


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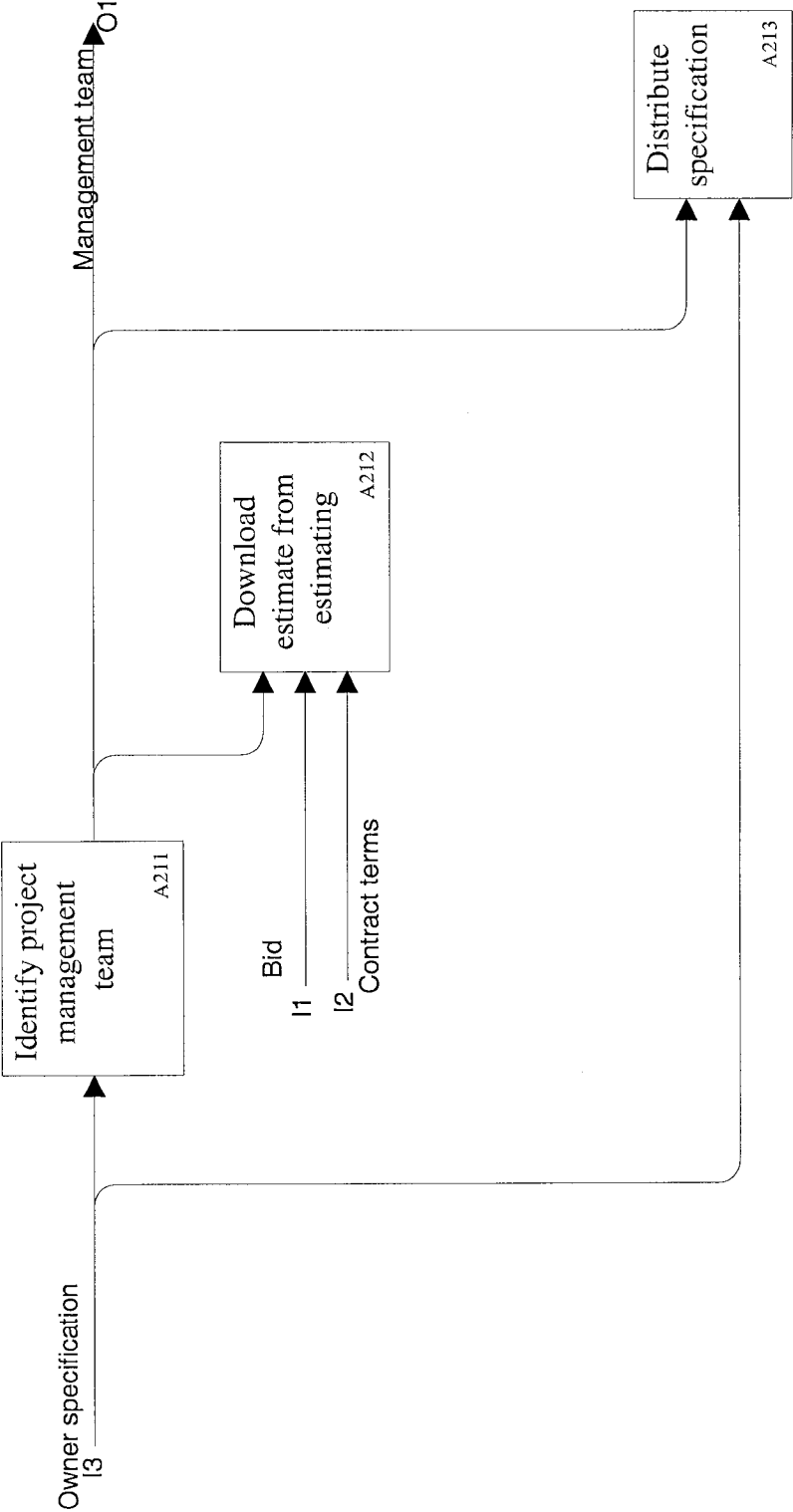


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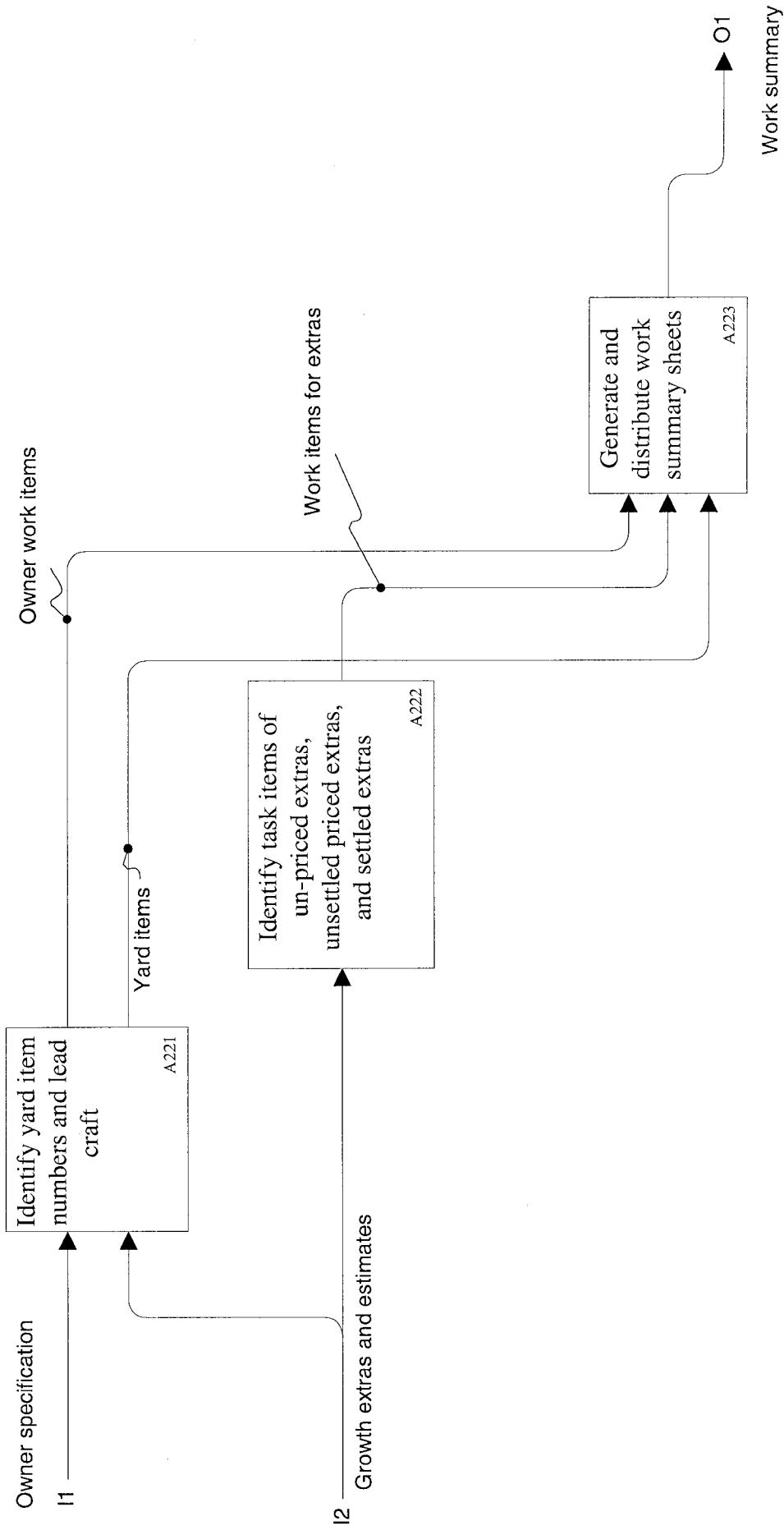


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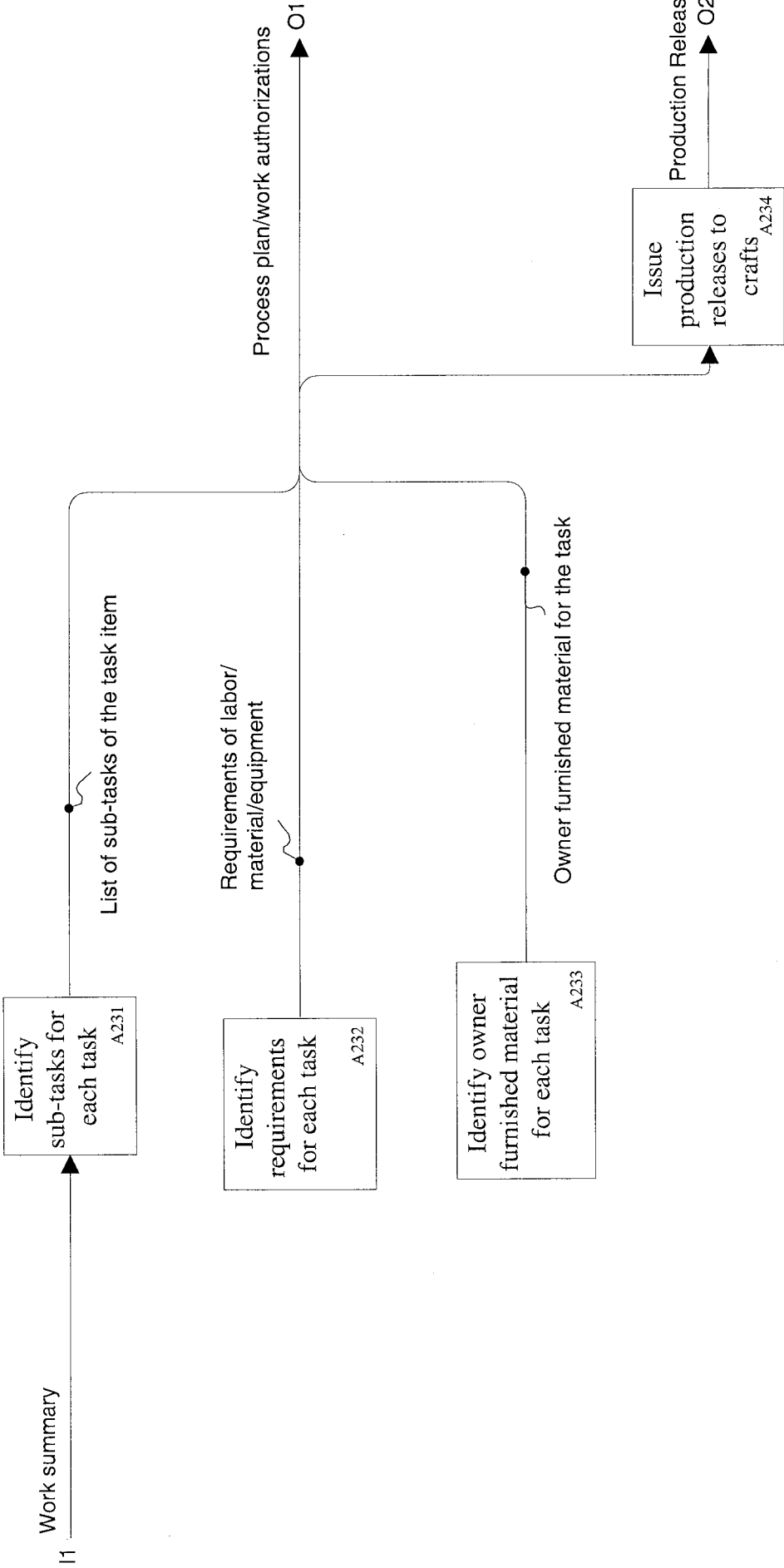
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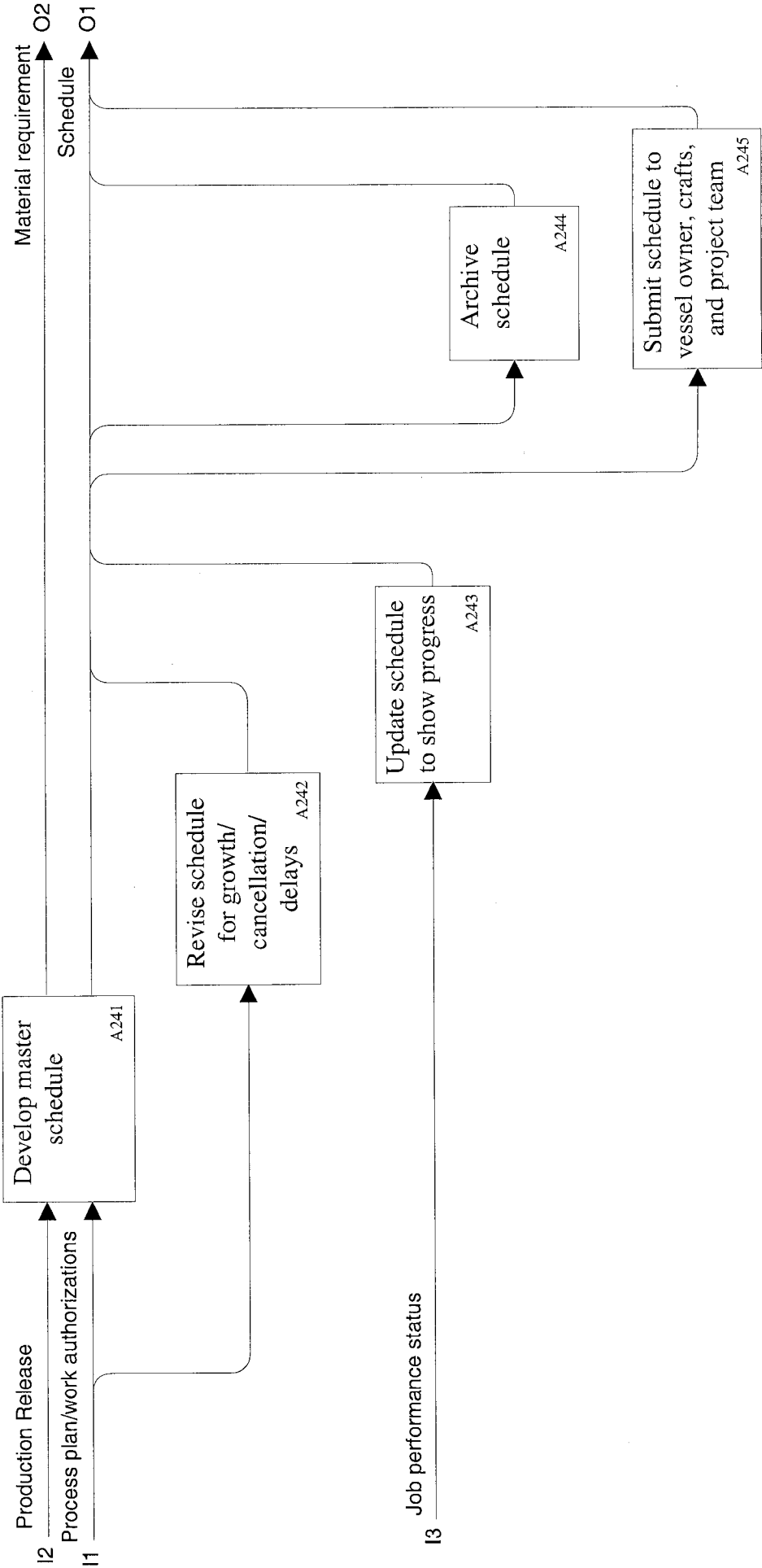
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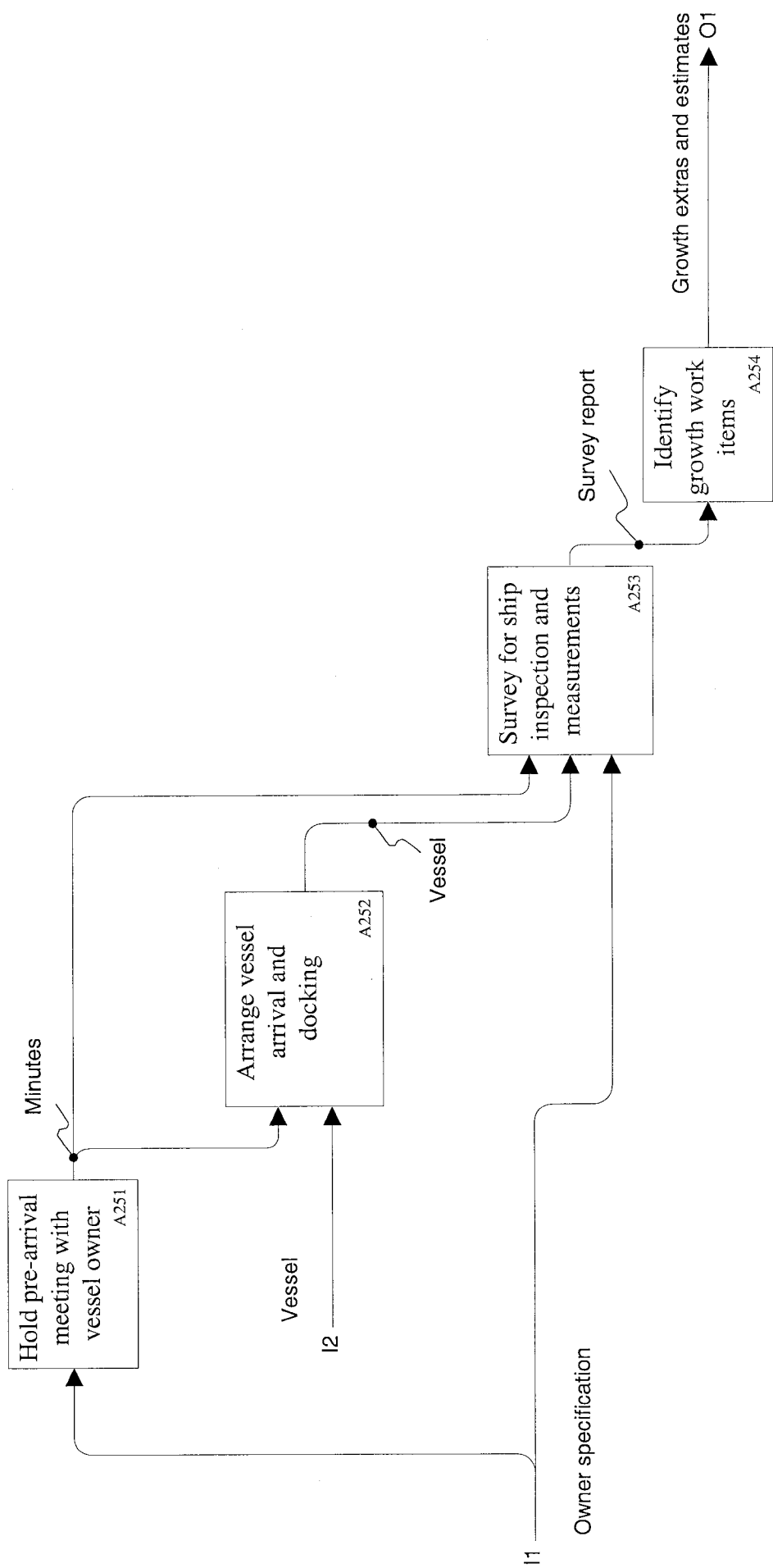
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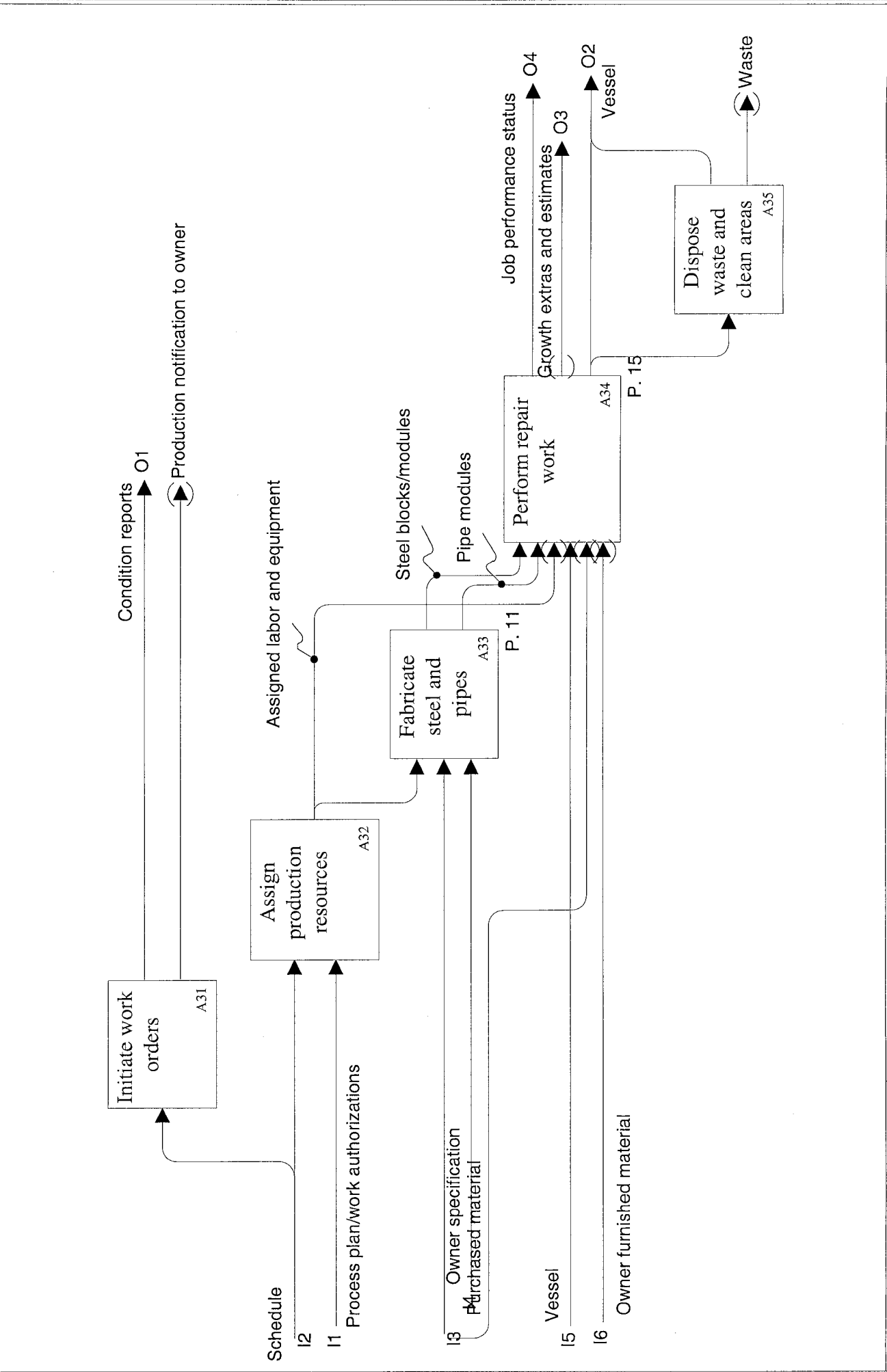


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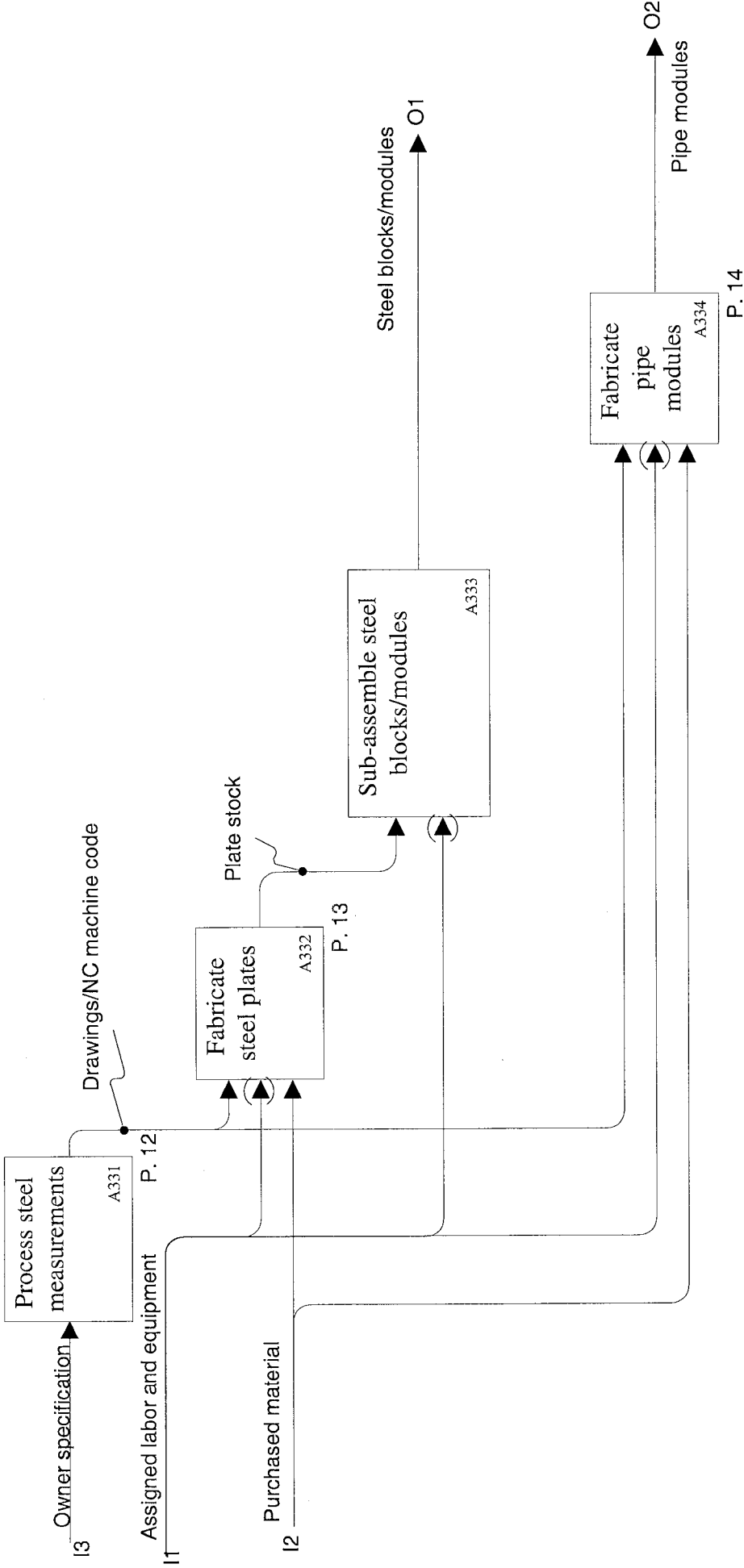


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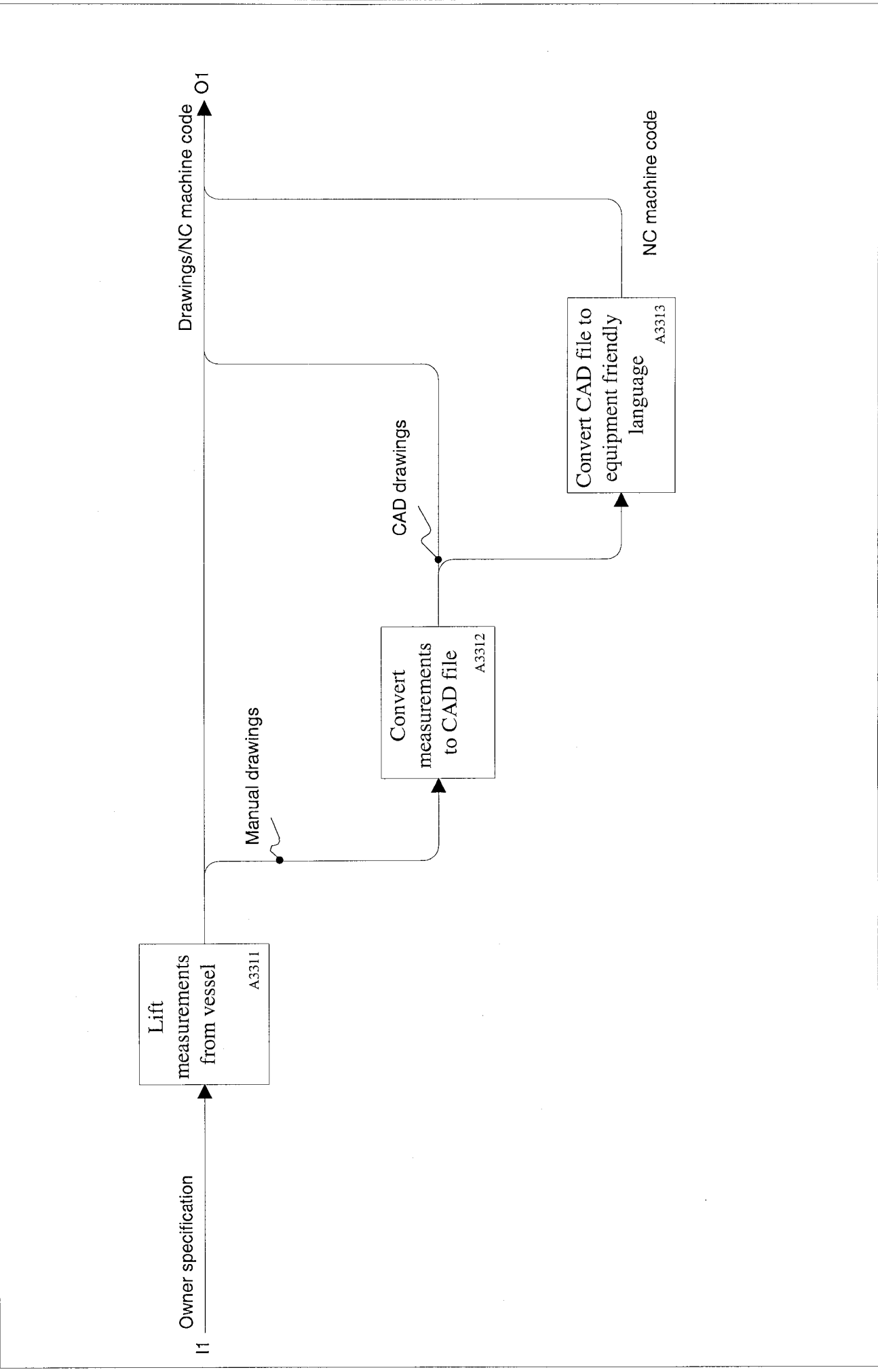




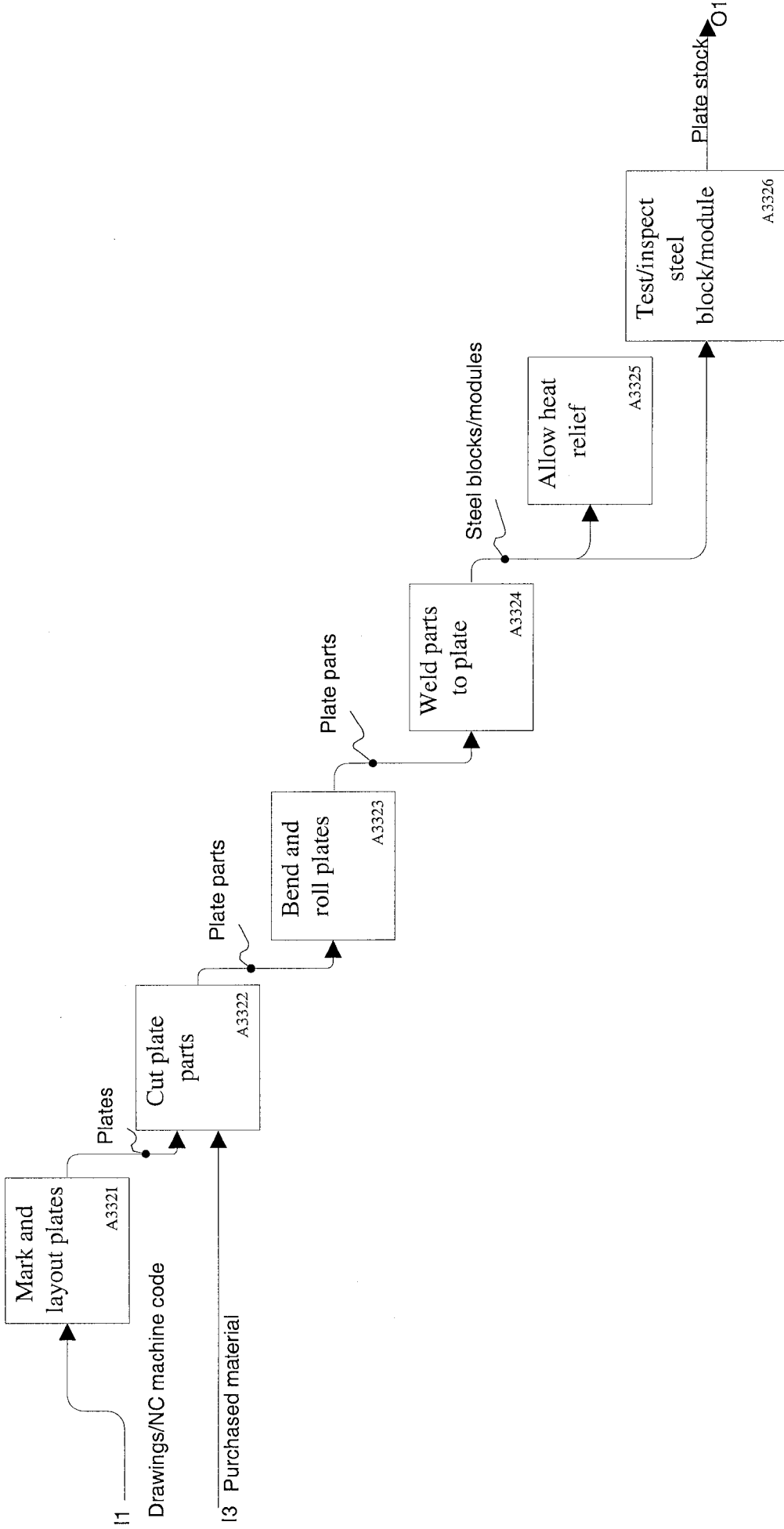
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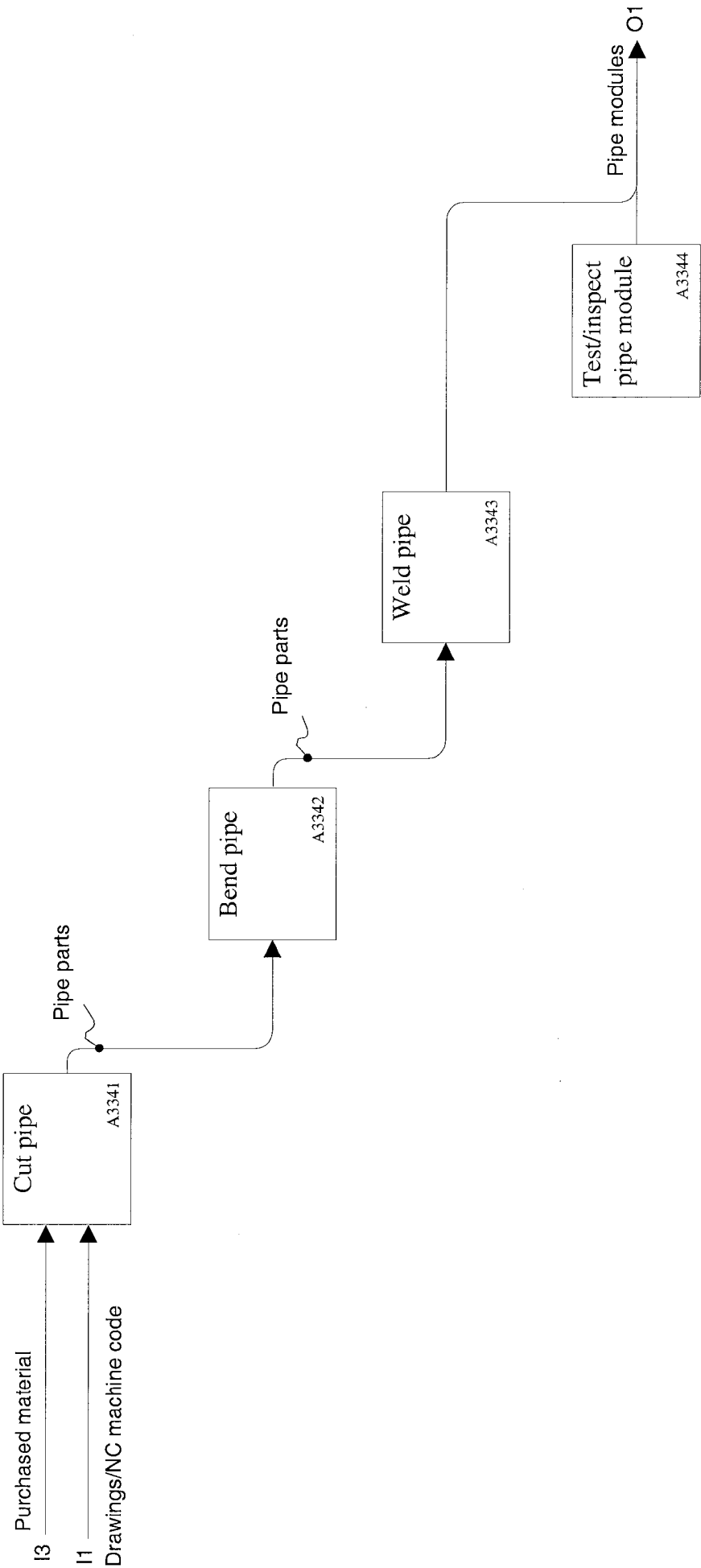
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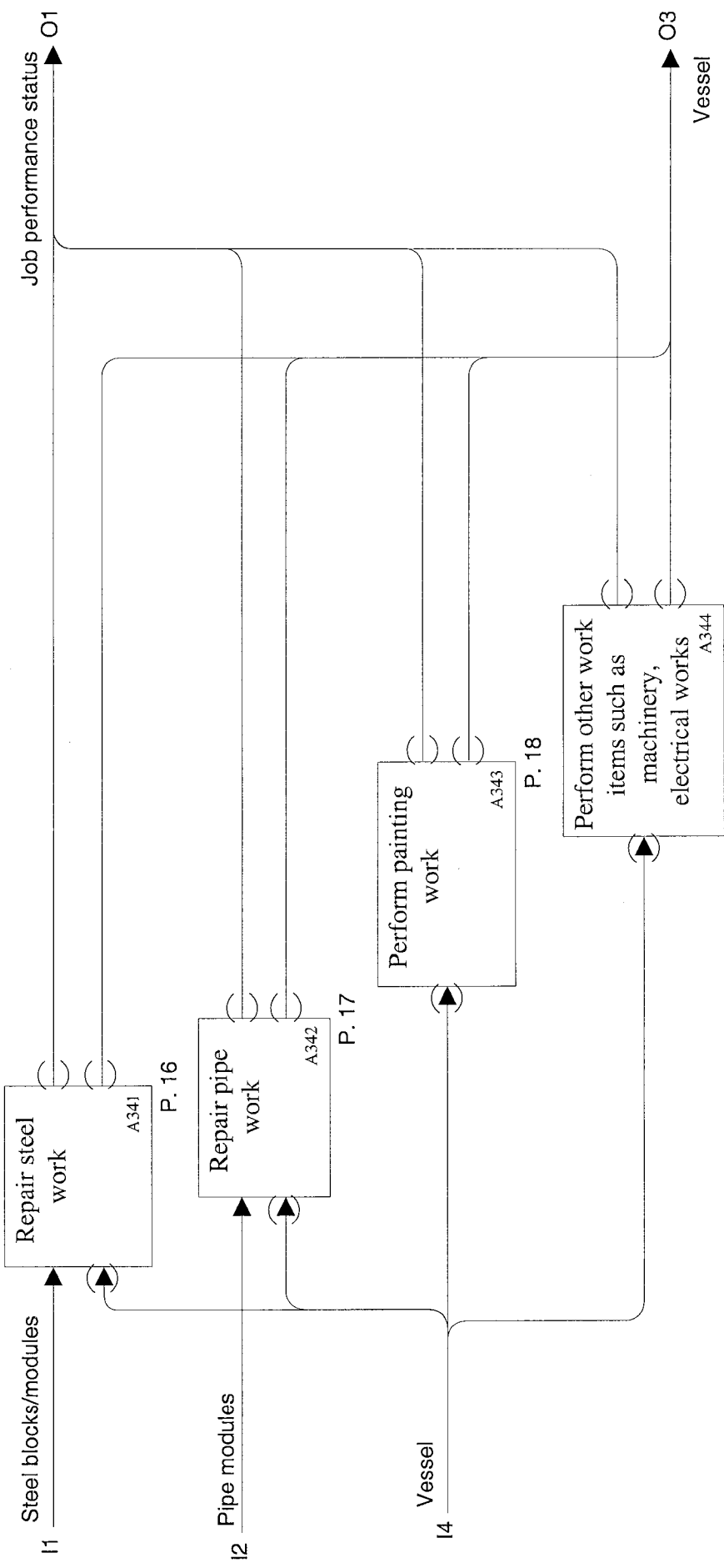
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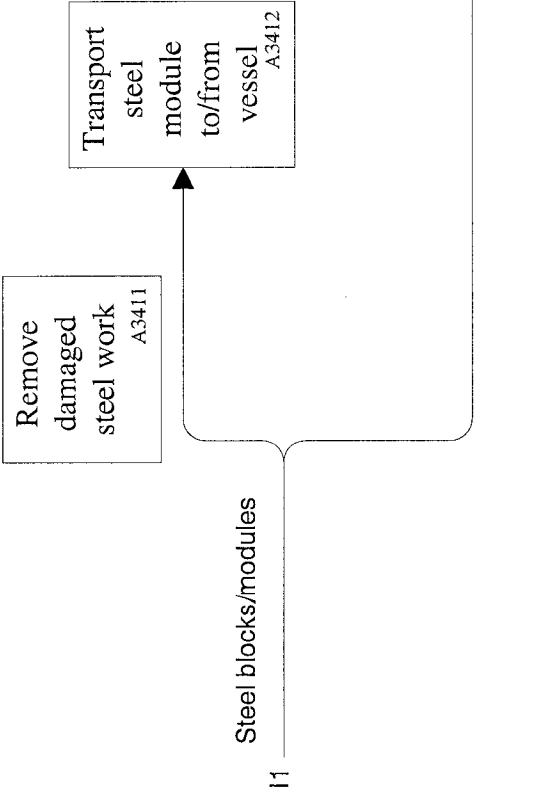
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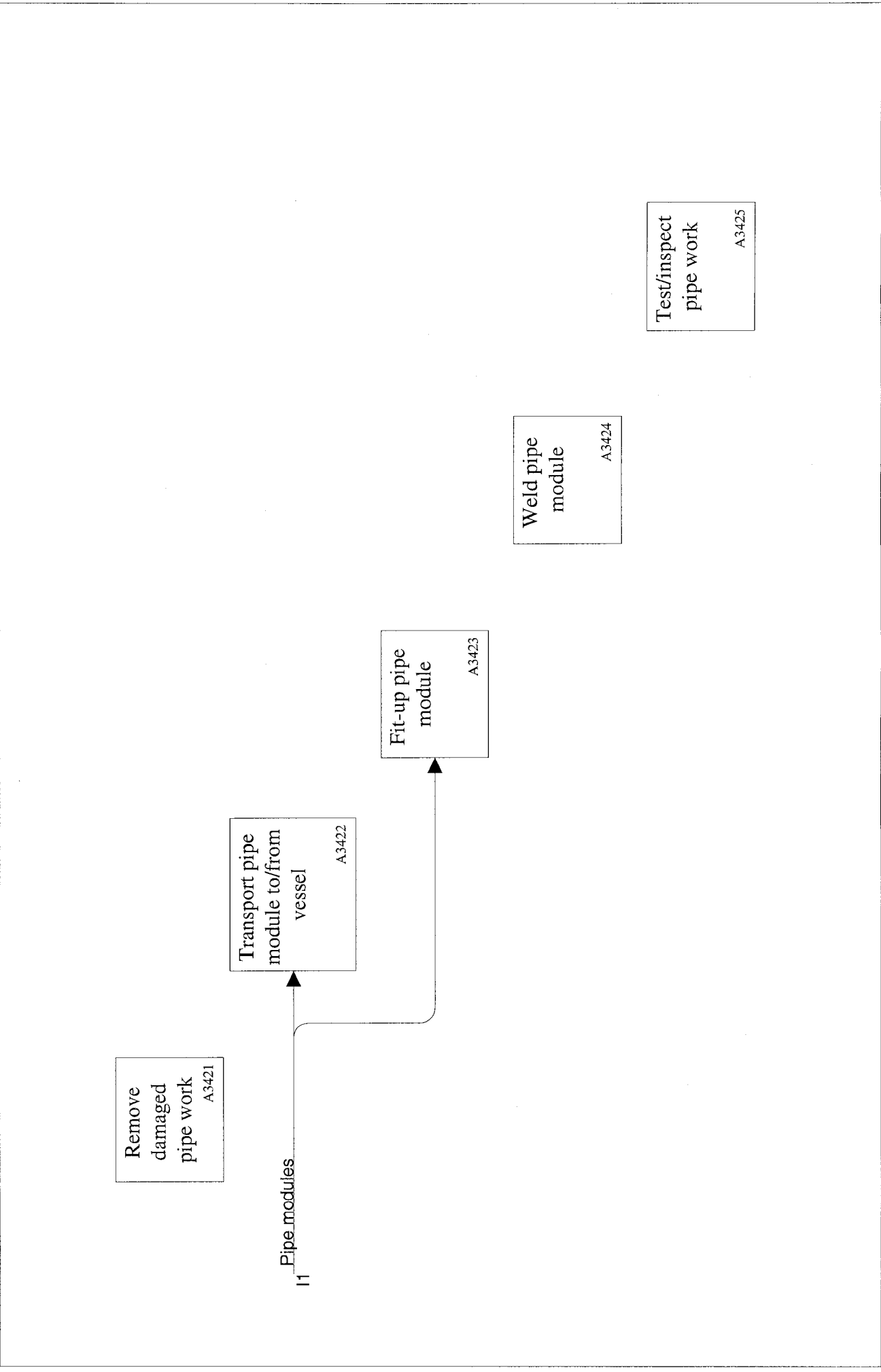
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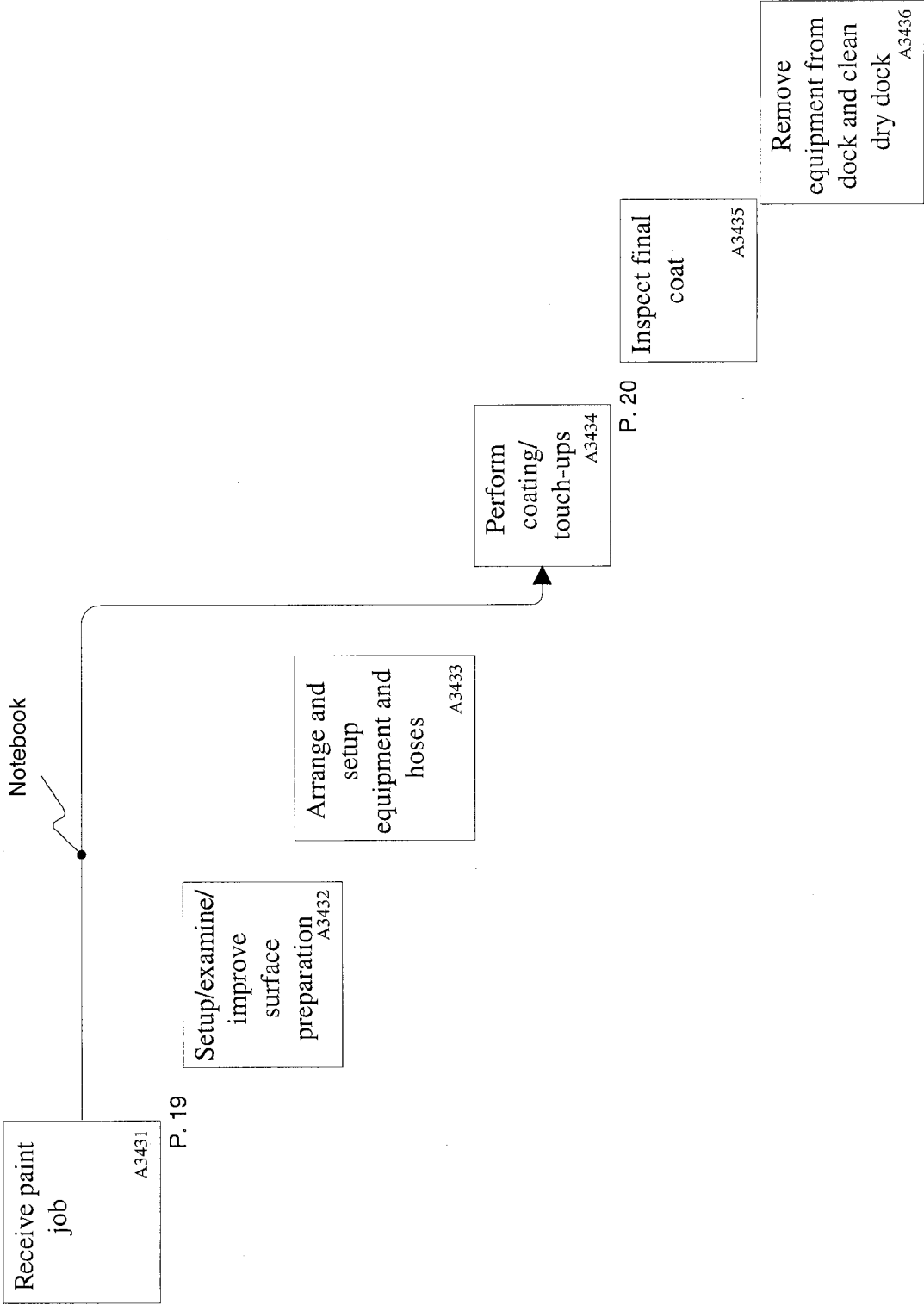
Weld steel module
A3414

Test/inspect steel work
A3415

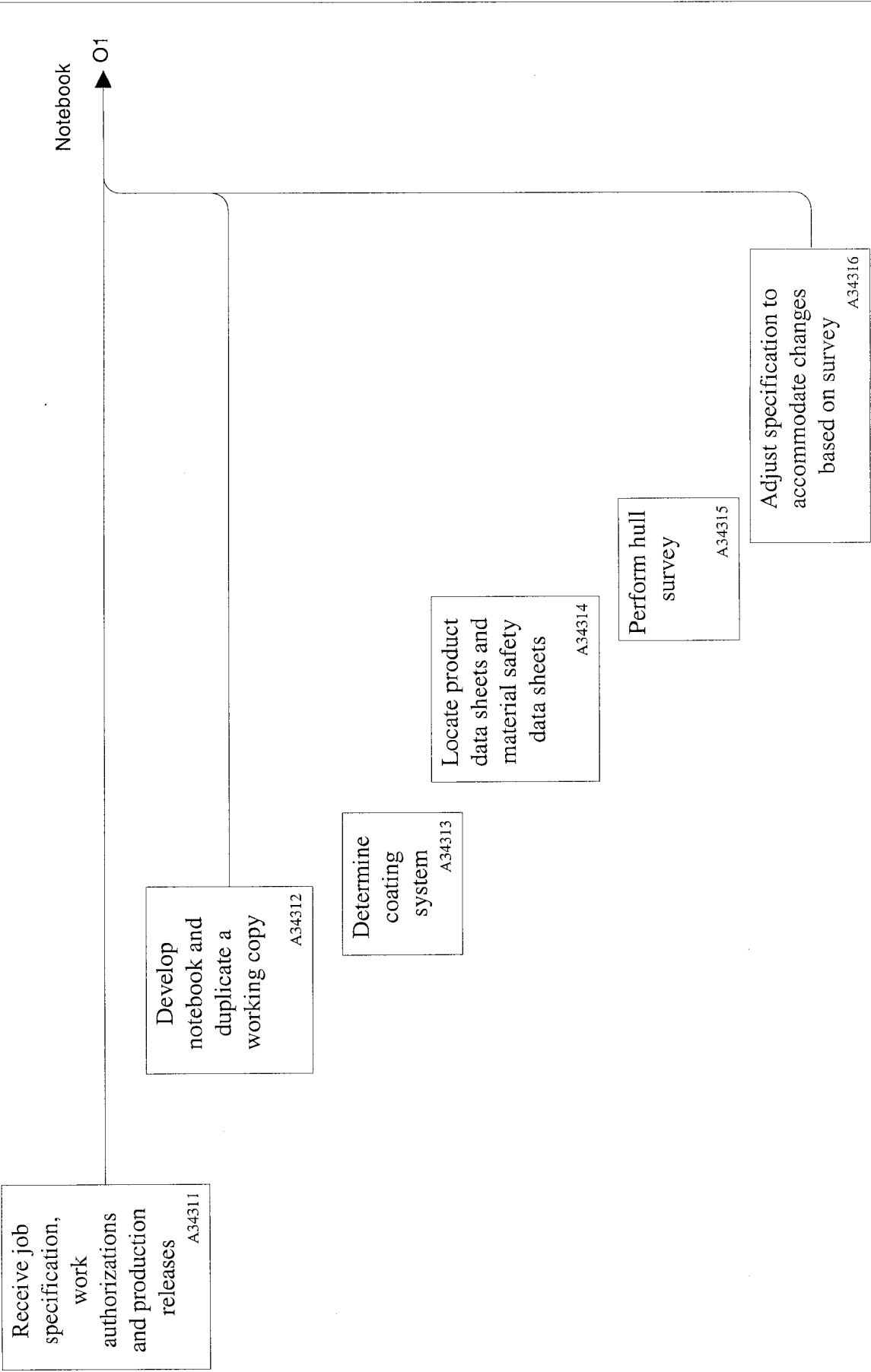
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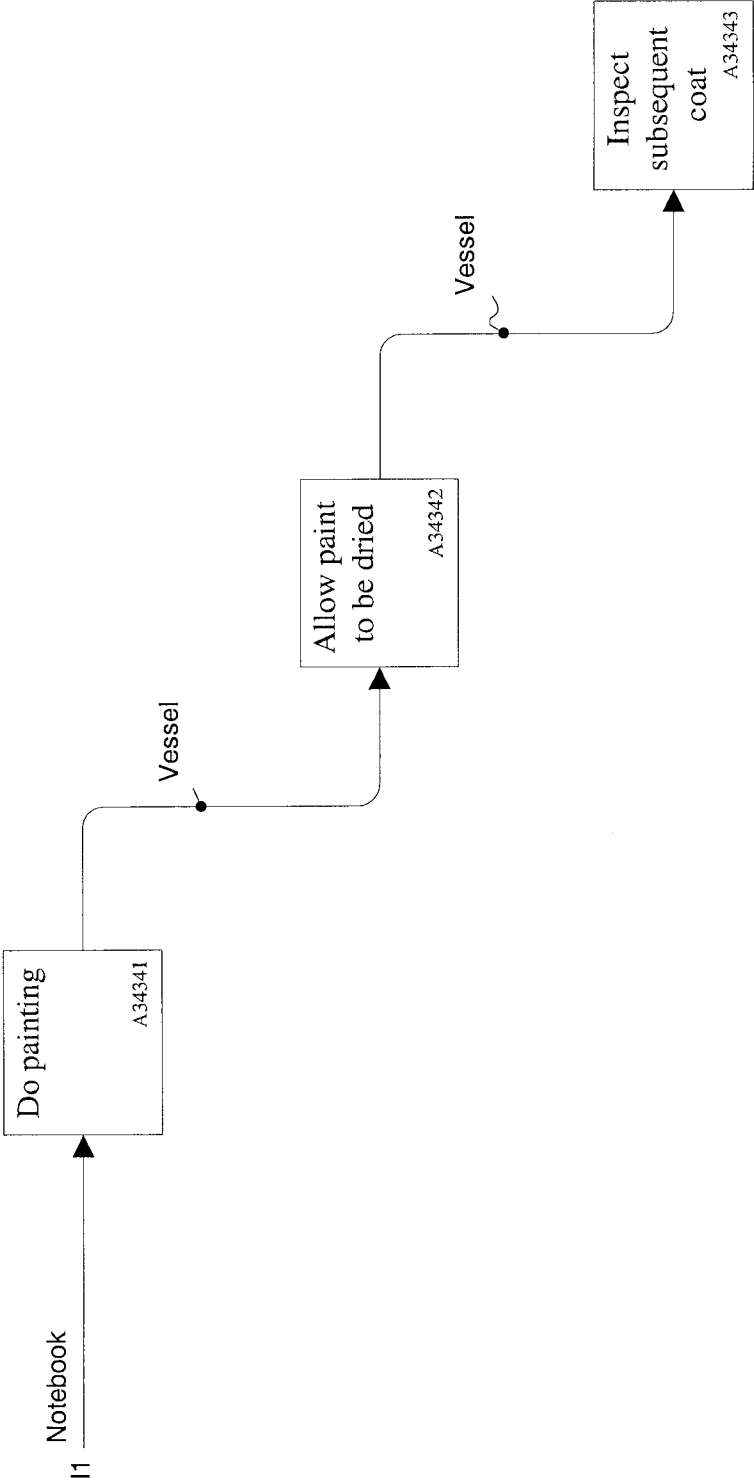
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				PUBLICATION			



USED AT:	AUTHOR: Tina Lee	DATE: 07/10/00	x	WORKING	READER	DATE	CONTEXT: ■ □ □ □ □ □ □ □
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USED AT:	AUTHOR: Tina Lee	DATE: 07/10/00	x	WORKING	READER	DATE	CONTEXT:
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